THE ADEQUACY OF TECHNOLOGY FOR POLLUTION ABATEMENT

by Emilio Q. Daddario

I am pleased to be a participant in this Rice University Research Day because it appears to be exactly the sort of bridging communication between science and society that is so badly needed. When Lord C. P. Snow keynoted our committee's seminar last year on the subject of "Science and Public Policy" he put it this way: "The purely scientific education is incomplete, but a purely nonscientific education is also incomplete." Thus, the university, in arranging this program, gives each of us a chance to continue and extend the learning process.

I can see from the list of speakers that environmental pollution is being considered in a broad context of regional planning, industrial aspects, ecological effects, and systems management. These many perspectives are certainly necessary in my view. The restoration and preservation of environmental quality will only be achieved when pollution abatement is considered a normal ingredient of commerce, industry, and urban governmental activity.

Too often in the past, the environment has been used as a convenient and available means of waste disposal. While property rights might protect real estate from being used as a dumping ground, there was no similar protection for air and surface waters. The environment has been falsely undervalued and the costs of getting rid of used and discarded materials has become falsely cheap to society.

Thus, pollution abatement and the cleanup of the landscape require substantial economic reshuffling and will cost a great deal of money. This is the root of the antagonisms which have built up between industry and government, naturalists and land developers, upstream and estuarial cities, and among political jurisdictions. Conventional market place economics have not accounted for the costs of waste disposal nor the damage to environmental quality. These values have not been properly included in the current system of public and private operations.

Editor's Note: The Honorable Emilio Q. Daddario (D.-Conn.) is Chairman of the Subcommittee on Science, Research, and Development, United States House of Representatives.

As a matter of fact, the best definition of environmental pollution that I know is simply: waste management gone wrong. There is a strong implication in this definition that the solution to the problem lies with the managers of industry and government. That is why this conference seems to me to be an important step in the right direction. The Houston area, as was pointed out in a recent *Time Magazine* article, is a prime example of the contending needs and uses which we place on air and water resources. Good management decisions cannot come easily in our urban complexes. More information and mutual understanding will certainly help.

Today, I would like to briefly review a Congressional study of the adequacy of technology for pollution abatement.

As Chairman of the Science, Research, and Development Subcommittee of the House Science and Astronautics Committee, I have been working for several years on the broad study of national objectives which could be seen to be highly dependent on effective utilization of the scientific and engineering resources of the United States. The goals in national defense and space technology are obvious, but we have been particularly interested in other areas where science and engineering can be used to support Federal agency missions, private sector prosperity, and State and local public needs. Pollution abatement was identified immediately as one of the most pressing and complex concerns of the future.

Last summer, the Committee held hearings over several weeks which presented testimony from 28 representatives of government at various levels, plus industry, universities, research institutes, and citizen action groups. The premise of the hearings was that the same technology which underlay our remarkable standard of living would be the means of maintaining and improving the quality of living.

We wanted to know what technology was available for abatement now and what further research and development must be undertaken. The estimates of capital expenditures needed for the "catching up" phase of waste management are in the tens of billions of dollars. Annual operating costs are quite probably several billions of dollars. Thus, pollution abatement ranks in cost with other major technological programs of the country. The most advanced technology will be necessary to deal with certain contaminants, and more efficient technology can lower costs in waste treatment processes which have changed very little from the time man first gathered together into cities.

Although economic and institutional barriers are often cited as the pacing factor in waste management and control, it is clear that cheaper abatement methods, and an improved knowledge of the effects of pollutants will help overcome the natural tendency for the status quo. If we know what we have to do and how to do it, then the necessary public will power and purse-power can be found.

Here are some of the impressions and findings of our hearings:

We are the polluters and the polluted, and our own senses tell us that the surroundings are not right. There is no need for detailed instrumental measurement or for emotional appeals of naturalists; today we all freely admit that we have a problem. Further definition of the problem, however, becomes a very difficult project involving natural and social sciences, economics, and governmental and private institutions. Making appropriate choices as we proceed will depend on much more knowledge than we now have.

The hearings illuminated the distinctive changes today in man's relationship to the environment—differences which have occurred only within the past few decades and which make the preservation of natural resource quality so imperative. First, almost all the desirable areas of the earth are populated. There is no longer the possibility of choosing convenient dumping grounds or streams or air currents without infringing on the rights or property of others.

Second, our power to disturb or alter the ponderous forces and rhythms of nature by man-induced manipulations has increased to the point where mistakes or unknown effects may be profound and irreversible. These powerful forces have only come about recently and are not well understood. As a consequence, in many risk-benefit questions, the magnitude of the risk is relatively unknown.

Third, none of our natural resources is in so great a supply that it can any longer be considered inexhaustible or truly consumable. A highly industrialized society in a heavily populated world suggests that (apart from energy) all resources must be perpetually reused, renewed, and recycled.

Finally, the hearings indicated that environmental quality, with its deep roots in the natural sciences, has not yet attracted sufficient attention from the scientific and engineering community. This is a problem worthy of the very best thinking we can muster.

In addition to imaginative and competent science and engineering, the problem demands a research strategy including the systems analysis and management approach which has proved useful in other large, complex technological programs.

Other than in the case of gross and obvious pollution, there is insufficient information to set ultimate objectives, criteria, and standards. The directions of improvement are usually clear enough so that near term objectives can be set in terms of percent reduction. But short of the unrealistic zero point, few limiting conditions or ultimately allowable concentrations can be specified on a scientific basis. Nothing about the testimony suggested that present legislation has gone beyond the existing technological basis. But the urgent and insistent nature of the Clean Air

Act and Water Quality Act is a strong stimulus to R. & D. to provide more knowledge and better techniques.

Firmly established criteria and standards for environmental quality are necessary to give industry a basis for planning and action. Only then will the science and engineering resources in the private sector be fully motivated. These skills and facilities are needed to solve internal corporate problems, and to meet the market demand for abatement processes and techniques which enforceable standards will generate. Therefore, the immediate research needs are in (a) improved abatement methods for gross and obvious pollution, and (b) ecological and human health data for criteria and standards setting.

Complete solution of pollution problems may not be possible, but two trends are discernible. More recycling of materials is a way of managing and eliminating wastes as well as a sound conservation policy. The impact of recycling on the economy can be lessened by imaginative product and process design. The other trend is the controlled transport of unusable wastes to some sort of perpetual safe storage. The use of ocean depths, deep wells, salt domes, burial, and caves needs careful study to assure that there are no undesirable effects on the biosphere from such disposal.

There is no longer any doubt that the people of the United States want to have clean air, clean water, and a clean landscape. The early years of development of our country were characterized by struggle with nature, the "winning of the West," and exploiting of natural resources for the wealth to build a nation. In a later period, dust and smoke were billowing signs of progress and industrial growth, the pride of towns and cities. Now we have come to realize that contamination with wastes is an unwanted (and unnecessary) consequence of a highly technical society.

Through all of our history, an empathy with nature has been important to Americans. The great conservation and recreation movements of this century are examples of the willingness to pay for environmental preservation, and of the enjoyment obtained from pleasant, healthy surroundings. The hearings indicate an unwillingness to sacrifice these values to more tangible ingredients of the standard of living. And yet it is clear that the long delay in recognizing the causes of environmental deterioration has allowed patterns of industry and society to become set in enormous investments. Changes in operations, new abatement facilities, and alterations of habits are now necessary. Naturally, the hope is that this "catch up" effort will be quick, efficient, and fair to all concerned.

The overall goal is to restore and maintain the quality of the environment without disrupting the economy and the culture. This goal is ambitious and carries some aspects of both eating and having the cake. The very large price to be paid by each citizen for pollution abatement has not

been fully realized as yet.

As to the adequacy of technology, this must usually be judged against more precisely stated goals. For example, technology today can meet any technical goal for purifying effluent water, even if the method must involve distillation. What we cannot do is simultaneously provide extreme purity at a cost that fits the value which society now places on surface streams and lakes.

Another example is a recent cost-benefit analysis of motor vehicle pollution by Dr. W. L. Faith. He correlates the number of days which could be made smog-free in different cities if nationwide adoption of effective exhaust control devices was carried out. The cost per smog day eliminated ranges from 10¢ in Los Angeles to $1.82 in Philadelphia. And if you live in an essentially smog-free area anyway, the cost of the device is simply a no-benefit tax. Thus, technological adequacy is quite relative to local situations and value judgments.

It is important to recognize that available technology can meet technical and cost goals to a far greater extent than it has yet been called on to do. Even so, much more research, development, and demonstration will be required to extend the ability toward higher efficiency at lower cost.

With respect to the general goal, some statements can be made with confidence as to what we know.

The obvious and obnoxious cases of pollution should be eliminated as soon as time and money required for construction of abatement facilities will permit. Such pollution is usually the result of contaminants which are in a different physical phase from the environmental carrier. That is why they are noticeable and also why they are relatively easy and cheap to remove.

For example, particulate matter (dust, smoke, fly ash, etc.) in air; suspended matter in water which leads to sludge; and floatable matter in water, including oil slicks—all can be taken care of today. Pittsburgh is an example of a city with cleaned air. The goals of the Ohio River Sanitation Commission specify freedom from floatables and suspended material.

The remedies are low cost in comparison to the benefits. While it may be that further R. & D. will decrease capital and operating expenses, such prospective improvements can probably be incorporated into existing plants, so no delay is justified. The thousands of sewage outlets to major streams should be systematically identified, and the disposal of raw, untreated sewage to lakes, streams, and rivers should be completely eliminated.

Although there is ample opportunity to apply available technology, some targets are frequently illuminated and popularized which could await attack until more knowledge is obtained. For example, electric power could be generated with no pollution threat to metropolitan areas by mine-

mouth coal burning plants or nuclear power. But the wastes are only removed to some other area and their eventual disposal may still be difficult. The separation of storm and sanitary sewers has been recommended, but recent evidence indicates that the contamination from streets, sidewalks, and city surfaces would make the runoff from rains quite a pollutant to receiving waters, even if it did not contain sewage. Therefore, the very expensive reconstruction of city sewer systems would not yield comparable increases in quality in the receiving water.

The most difficult areas in which to judge the adequacy of technology are those where subtle biological effects are concerned, or where the quality is impaired in esthetic terms, such as the color of water or the odors in air. For example, the carbon dioxide "greenhouse" effect requires a great deal of study before any action is taken. It may be technically possible to avoid these contaminations, but the benefit is difficult to evaluate. In many instances, the threat is not great or immediate. We have the time to do much more research on cause-and-effect relationships and on efficient, economical remedies. The funds for abatement installation programs obviously have some limits. Therefore, the pursuit of doubtful or incompletely understood problems should not detract from the continued effort in cleaning up well-known problems.

Our hearings also identified pollution problems which urgently need solutions but for which no technology is adequate today. I believe other speakers will go into some of these in technical detail so I will merely list a few research needs.

The internal combustion engine is the only logical power source for personal transportation for some time to come in the United States. Much must be done to reduce combustion inefficiencies. The production of nitrogen oxides in the engine may prove to be a serious pollution problem and there are no remedies at present.

Lead contamination from motor fuel may be judged hazardous enough to require a drastic revision in petroleum processing or engine operations. Alternative antiknock additives which do not bring new contamination problems would be valuable.

Since air pollution is often episodic, a greater ability is needed to predict the time when contaminant concentration and meteorological conditions combine to produce hazard.

Fossil fuel electric power generation in very large urban plants is reaching a crisis because no means are available for sulfur dioxide removal or for high efficiency collection of very fine particulate matter.

Nuclear electric power expansion may bring quantities of reactor wastes which exceed the present capacity for so-called perpetual surveillance in underground storage.

The reuse of water may be limited by the inability to remove viruses

and certain organic chemical contaminants.

The plant nutrients in treated sewage are causing upheavals in aquatic biology which damage lakes and estuaries.

Mine drainage cannot now be controlled short of processing entire streams.

The ocean and other storage sinks are still a part of the total biosphere. We should know much more about distant ecological relationships before using them as dumping grounds on a large scale.

Thus, there are many areas where science and engineering must come up with new facts and know-how before pollution abatement can move forward. There are indeed some technological inadequacies.

A final point, which I would put to you as a challenge, is: how to deal with the new concept of cause-and-effect relationships. Human health and environmental damage are, and will continue to be, a powerful motivation for pollution abatement. But the linkage of cause and effect will be subtle, sophisticated, and will involve long time periods, even generations.

In many instances, the consequences of technological decisions will not be recognized at an early enough time to take them into consideration. I am interested in trying a new institutional approach to seeing that more of the costs and more of the benefits are included in the equation when society is called on to embark on new large-scale manipulations of the landscape, or to choose between alternatives. For example, should we go rapidly ahead with nuclear electric power to ameliorate sulfur dioxide air pollution in cities? Or would such a decision produce atomic wastes in a volume we are not yet able to handle? Will continued large-scale combustion of fossil fuels add sufficient carbon dioxide to the atmosphere to change the radiant energy balance and world-wide climate?

Late last year, our Science Subcommittee issued a report, looking into the future, which emphasized this highly important fact: "We must be cognizant of what technology is doing to us—the bad as well as the good. Toward this end we could consider the exploration of legislation to establish a Technology Assessment Board . . . with the function . . . of keeping tab on the potential dangers, as well as the benefits, inherent in new technology and simultaneously informing the public of the nature of them." I have now drafted legislation to create such a Board, and I expect to introduce a bill in the House in the near future.

I do not at this time want to go into the details of the Board except to quote to you briefly its functions as the bill is now drawn:

(1) to make a continuing assessment of applied research and technology, current and potential;

(2) to identify (A) ways in which such applied research and technology might be utilized to advance the social, economic, international, and other interests of the United States, (B) areas of

applied research and technology which require greater emphasis or support in order to advance such interests of the United States, and (C) areas or aspects of applied research and technology which may be or may become detrimental to such interests of the United States; and

(3) to determine and recommend how such benefit might be utilized, or how such detriment might be avoided, and inform the public with respect thereto.

Let me emphasize that the bill is being introduced primarily for discussion purposes and to create additional dialogue on the problem. I would expect some rather drastic revision between the bill I have drawn and whatever measure may later be considered by the Congress.

Along with any enhanced ability to prevent environmental hazards, our laws must evolve to recognize the importance of many complex and yet subtle relationships. For example, natural gas could replace sulfur-containing coal and oil in urban power plants to relieve the sulfur dioxide pollution situation. But the Federal Power Commission complained in a recent case involving more gas for Los Angeles:

> The witness from HEW's Public Health Service presented by the staff stated his opinion that a concentration of 0.1 ppm is about the lowest 24-hour average concentration which has been associated with undesirable effects on human beings. Without citing any materials of which we could take official notice. HEW now states in pleadings and oral argument that there is no scientific assurance that lower concentrations will *not* affect human health. As commendable as this view may be in terms of scientific caution, it simply does not provide this Commission with any meaningful guidance.

The establishment of firm, legally acceptable relationships between long term, low level exposure to air contaminants and damage to human health or longevity may be extremely difficult. Some students of environmental epidemiology say it will be impossible.

We can no longer judge behavior by its immediate consequences on those in the vicinity. Some of the things we do have a sort of numerical probability of injuring persons we never see—or who are perhaps yet unborn. Can our social system deal with a statistical responsibility for environmental quality which we all share? Can the subjective evaluation of esthetic benefits and damages be given proper weight in administrative and judicial proceedings?

The economics of pollution also fit a pattern which is inadequate. Whenever abatement action is suggested, the costs are quickly calculated as to the exact amount to be added to each electric bill, tax statement, or price tag, or to be deducted from stock dividends and profits. But the benefits of improved environmental quality, or the damages to health and well-being, are most often nonquantitative, fuzzy, and in disagreement.

The foregoing examples suggest the magnitude of the challenge to government and industry in pollution abatement. New technology, more scientific facts, legislation, and money are required. But most of all, a new viewpoint is called for. Old schemes of values and former economics ignored waste management and its ecological consequences. The new criteria for the quality of civilization will recognize a long-range strategy for the use of natural resources and biological processes to the benefit of humankind. The tactics in immediate actions should be consistent with this ecological viewpoint.

The dialogue which is being carried on here today is an essential step toward consensus on the management of technology by society.